Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	**)**	
	)	
GE Healthcare Petition for Rulemaking	**)**	ET Docket No. 08-59
for New Medical Body Area Network	**)**	
Service at 2360-2400 MHz	**)**	

To: The Commission

REPLY COMMENTS OF GE HEALTHCARE

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INTRODUCTION AND SUMMARY

GE Healthcare ("GEHC") hereby submits this reply to the comments submitted by other parties in response to the Commission's Public Notice in this proceeding. 1/ Many of the comments submitted thus far discuss the significant benefits that would be generated by an allocation of spectrum at 2360-2400 MHz for Medical Body Area Network Service ("MBANS") operations. In response to those comments that raise questions regarding the compatibility of MBANS operations with incumbent operations in the band, this reply demonstrates that the fears expressed are exaggerated at best. GEHC believes that any compatibility issues that remain after the submission of this reply can be resolved satisfactorily and constructively during the rulemaking. GEHC therefore urges the Commission to move forward expeditiously with a

1/ *Office of Engineering and Technology to Treat Ex Parte Comments of GE Healthcare as Petition for Rule Making and Seeks Comment*, ET Docket No. 08-59, Public Notice, DA 08-953 (rel. Apr. 24, 2008) ("*Public Notice*").

Notice of Proposed Rulemaking ("NPRM") seeking comment on a proposed secondary allocation for MBANS in the 2360-2400 MHz band.

I. COMMENTS DEMONSTRATE THE CLEAR BENEFITS OF AN MBANS ALLOCATION

The record reflects broad support for the allocation of additional spectrum for MBANS, validating the Commission's desire, represented by the MedRadio Notice of Inquiry ("NOI"), to proactively address unmet spectrum needs for advanced wireless medical devices. Several medical practitioners express support of the MBANS proposal. For example, Marilyn Rantz of Sinclair School of Nursing, presenting the perspective of a nurse and expert in long term care and aging, states that "[i]f we are to manage the enormous population of older adults in our society and begin to meet their chronic illness needs, technology must be developed that can be used to support home and community based care as well as traditional long term care services. Dedicated radio spectrum frequencies for the wireless communication of these technological advances are critical to their success." 2/ Lisa Gaudet of Northeast Health argues that an MBANS allocation would permit "more pervasive monitoring of our patients. This will offer improved quality outcomes, efficient use of resources, and better quality of life for our patients." 3/ Dr. David Pugliese conveys the benefits of wireless remote patient monitoring with regard to logistics, quality of care, and uninterrupted monitoring for a patient moving among areas of the hospital. 4/ Dr. Michael Shabot, M.D. adds that "[MBANS] would free critically ill patients from electrical patient monitoring cables that are inconvenient, obtrusive and even

2/ Comment of Marilyn Rantz, RN, PhD, FAAN, Professor, Sinclair School of Nursing, University of Missouri, ET Docket No. 08-59 (filed May 22, 2008) at 1.

3/ Comment of Lisa Gaudet, ET Docket No. 08-59 (filed May 23, 2008) at 1.

4/ Comment of Dr. David Pugliese, ET Docket No. 08-59 (filed May 29, 2008) at 1.

unsafe at times. If these cables could be eliminated with a Body Sensor Network, patients would be more comfortable and physicians and nurses would be able to provide better care." 5/ Kim Bonzheim of William Beaumont Hospital, commenting in support of the proposal, cites the importance of WMTS, and conveys the trend towards electronic medical record (chart) and cites the "need to send electronic clinical data on a regular basis to the chart. The reliability of these patient monitoring systems is critical to safe patient care enhanced by real time clinical data. In addition, the ability to reduce or eliminate wires and cords would be a significant benefit to caregivers." 6/

To further appreciate the importance of an MBANS allocation to improving health care delivery and efficiency, consider the National Health Expenditure ("NHE") compiled by the Department of Health and Human Services. The NHE fact sheet 7/ includes the following statistics:

- NHE grew 6.7% to $2.1 trillion in 2006, or $7,026 per person, and accounted for 16% of Gross Domestic Product ("GDP").
- Medicare spending grew 18.7% to $401 billion in 2006, or 19 percent of total NHE.
- Private spending grew 5.4% to $1.1 trillion in 2006, or 54 percent of total NHE.
- Hospital expenditures grew 7.0% in 2006, a slightly slower rate than the 7.3% in 2005.
- Growth in NHE is expected to remain steady at 6.7 percent in 2007 and average 6.7 percent per year over the projection period (2006-2017).

5/ Comment of Dr. Michael Shabot, M.D., ET Docket No. 08-59 (filed June 3, 2008) at 1.

6/ Comment of Kim Bonzheim, Director, Cardiac Services, William Beaumont Hospital, ET Docket No. 08-59 (filed June 4, 2008) at 1.

7/ National Health Expenditure (NHE) data from Department of Health and Human Services, Centers for Medicare and Medicaid Services. Available via the Internet at http://www.cms.hhs.gov/NationalHealthExpendData/25_NHE_Fact_Sheet.asp#TopOfPage. Last accessed June 11, 2008.

- The health share of GDP is projected to reach 16.3 % in 2007 and 19.5 % by 2017.
- Spending on hospital services is projected to grow 7.5% in 2007 to $697 billion. Average growth of 6.9% per year is expected for the entire projection period.

It is also important to understand the scope and breadth of the health care industry in terms of its workforce and consumers. The American Hospital Association ("AHA") 2008 Chartbook addresses trends affecting hospitals and health care delivery systems. Chapter 5 of the Chartbook 8/ lists statistics for 2006, including the employment of 4,343,480 full-time equivalent employees by hospitals and a total of 1,138,600 registered nurses. Chapter 3 of the Chartbook 9/ indicates that in 2006 there were 35,377,659 inpatient admissions and 599,553,025 outpatient visits at community hospitals. An MBANS allocation would help to reduce the costs associated with the delivery of health care services and patient interactions, increase the efficiency of health care providers and ultimately improve the quality of health care for a large population of consumers.

While, as discussed more fully below, GEHC firmly believes that an MBANS allocation could be established in the 2360-2400 MHz band without causing harmful interference to aeronautical telemetry (referred to herein interchangeably as "aeronautical telemetry" and "AMT"), it is nevertheless worth noting that the figures mentioned above for health care costs and related economic impact dwarf those related to the financial burden of flight testing and the

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8/ American Association of Hospitals, 2008 Chartbook, Chapter 5. Available via the Internet at http://www.aha.org/aha/research-and-trends/chartbook/ch5.html. Last accessed June 11, 2008.

9/ American Association of Hospitals, 2008 Chartbook, Chapter 3. Available via the Internet at http://www.aha.org/aha/research-and-trends/chartbook/ch3.html. Last accessed June 11, 2008.

contribution of the aerospace industry to the United States economy raised in comments by Boeing 10/ and the Aerospace and Flight Test Radio Coordinating Council ("AFTRCC"). 11/

The record compiled thus far also includes comments from academic researchers with significant experience in the investigation of body worn sensors and body area radio propagation. Drs. Scanlon, Hao and Alomainly attest to the technical suitability of the proposed 2360 to 2400 MHz frequency band for body area networks, given favorable radio propagation and antenna characteristics. In addition, Texas Instruments notes that it currently manufactures various low-power, highly integrated transceiver products for the 2400-2483.5 MHz unlicensed band that would enable MBANS devices operating at 2360-2400 MHz. 12/ Texas Instruments also affirms the unique suitability of the proposed 2360-2400 MHz band for enabling existing IC designs to be leveraged: "medical devices incorporating these chips could benefit from economies of scale -- and the corresponding cost-effective prices -- and from the ready availability of essential components." 13/

Finally, no commenter refutes the tremendous societal benefits (in terms of the increased efficiency with which health care could be delivered) that would result from an MBANS allocation. By all measures, such benefits more than justify the efforts necessary to launch an NPRM proposing the allocation. As the comments demonstrate, the Commission has a tremendous opportunity to kick start material advances in patient monitoring and health care delivery through the initiation and resolution of an MBANS allocation proceeding.

10/ Comments of The Boeing Company, ET Docket No. 08-59 (filed May 27, 2008) ("Boeing Comments") at 5.

11/ Comments of Aerospace and Flight Test Radio Coordinating Council, ET Docket No. 08-59 (filed May 27, 2008) ("AFTRCC Comments") at 10.

12/ Comments of Texas Instruments, ET Docket No. 08-59 (filed May 27, 2008).

13/ *Id*. at 3.

II. LOW UTILIZATION OF PROPOSED 2360-2400 MHZ BAND BY INCUMBENTS

As the Commission is aware, there exists virtually no unallocated spectrum below 3 GHz. Therefore, unless incumbent services are reallocated, any new services below 3 GHz will have to share spectrum with incumbents. The Commission's ground-breaking 2002 Spectrum Policy Task Force Report ("SPTFR") on spectrum efficiency recognized this situation and made specific recommendations, including:

> ***Taking advantage of time.*** The Commission should look at ways to expand the use of . . . technologies that facilitate and improve the sharing of spectrum between multiple users. The Commission should also consider authorizing the use of spectrum with typically low utilization by parties that are willing to operate on an interruption basis (i.e., suspend their operations when the primary licensee is transmitting).
>
> ***Taking advantage of space.*** The Commission should expand the ability of licensees to partition their service areas so that others may use the spectrum in places that the current licensee chooses not to provide service. The Commission should also consider issuing "white area" licenses that would permit new services to be offered in the unserved areas between existing services. 14/

GEHC's proposal for MBANS operation in the 2360 to 2400 MHz band represents a unique opportunity to enable beneficial new devices that opportunistically take advantage of space, time and frequency, given the sparse utilization of primary services in this band. In this way, the proposal is wholly consistent with the progressive approach to spectrum policy outlined in the SPTFR.

The policy approach outlined in the SPTFR dictates that the 2360-2400 MHz band be considered a prime candidate for more intensive use. In January 2008, AFTRCC provided GEHC with a listing of 165 flight test locations, 157 of which were located within the

14/ Federal Communications Commission Spectrum Policy Task Force, *Report of the Spectrum Efficiency Working Group* (Nov. 15, 2002) at 35.

continental United States. 15/ AFTRCC indicated that this listing represented both government and commercial flight test locations, some of which utilize 2360 – 2395 MHz for telemetry. These test flight locations are listed and mapped in Appendix A. This map represents the location of AMT receive antennas that are either fixed to government or commercial buildings or limited to the boundaries of flight test ranges.

Equipped with this information, GEHC performed a search of the Commission's Universal License System ("ULS") database on June 5, 2008. The ULS search criteria used by GEHC included regular and active licenses assigned to the aeronautical and fixed radio service ("AF"), within the frequency range of 2360 to 2400 MHz. This search yielded only 16 licenses, covering of a total of 32 site locations. These ULS search results are also included in Appendix A. The licensed sites are shown as blue dots with red squares on the AMT test site map, Figure 4 of Appendix A. Based on this map, it can be concluded that the AMT flight test receive stations, with their highly directive parabolic dish antennas, are very sparsely distributed across the continental United States.

Some simple analysis is helpful for appreciating the extensive portion the continental United States that is free of AMT receive operations. The following figures assume an exclusion radius around each AMT site in which MBANS operations would not be permitted in the 2360-2395 MHz subset of the proposed band that would be shared with AMT, and further conservatively assume that these exclusion zones would be completely non-overlapping geographically. If an exclusion radius corresponding to the 8.4 km separation distance computed for the worst-case of an MBANS device in the mainlobe of the AMT receive antenna in the coexistence analysis of Appendix B were applied to each of the 32 licensed S-band sites, 99.92

15/ This data was provided to GEHC by AFTRCC in spreadsheet format via electronic mail on January 15, 2008.

percent of the 9.1 million square kilometers of continental United States would remain available for MBANS operation in the AMT frequencies. If such exclusion zones were applied to all 157 AMT sites located within the continental United States, then over 99.61 percent would still remain available. Even if a 19.6 km separation distance, as is suggested by AFTRCC's very conservative analysis, were required and such an exclusion zone were applied to all 157 AMT sites, over 97.92 percent of the continental United States would still remain available for MBANS operation in the AMT frequencies.

By contrast, there are 6,853 hospitals located within the continental United States. 16/ These hospitals are mapped in Figure 1 of Appendix A. Each dot on the map represents one or more hospitals within the same zip code. A visual comparison of the hospital and AMT receive site maps further demonstrates the opportunity for spatial reuse of the proposed 2360 – 2400 MHz for MBANS operations. A statistical examination of the minimum separation distance between each hospital and the AMT sites is included in Appendix A. Only 0.07% of hospital sites are located within 1 km of an AMT receive site. If only AMT receive sites with an FCC license to operate in the S-band are considered, this fraction drops to only 0.03%. Only 2.0% and 6.1% of hospital sites are located within 9 km and 20 km of any AMT site, respectively. If only AMT receive sites with an FCC license for S-band operations are considered, these fractions drop to 0.7% and 2.0% of hospitals located within 9 km and 20 km, respectively. Ninety-nine percent of hospitals are at least 12 km away when only those AMT receive sites licensed by the FCC for S-band use are considered.

16/ Verispan (www.verispan.com) is one of the major providers of health care information and services. Verispan offers a commercial database of hospitals which was used by GE Healthcare for this effort.

In addition to the opportunity for spatial reuse of the 2360 to 2395 MHz band, there is also a significant opportunity for frequency reuse as well. Further review of the 16 FCC licenses for AMT operations shows limited use of the 2360 to 2395 MHz band at the licensed locations. Figure 3 of Appendix A contains a chart of the frequencies listed in the FCC licenses, according to the site at which they are used. With the sole exception of the Wichita, Kansas sites, only a small portion of the 2360 to 2395 MHz band is licensed for AMT usage at each flight test location and no channels above 2387.5 MHZ are licensed at all. Based on a review of the FCC licenses for AMT receive sites, it appears that there is a significant amount of spectrum in the 2360 to 2395 MHz band available for MBANS devices to operate without interfering with AMT receive site operations.

One must also consider the utilization of the proposed frequency band with respect to time. As Boeing comments, "[a]ircraft testing is an expensive endeavor." 17/ As AFTRCC explains 18/, schedules are developed which consider both human and equipment resources. Such tests do not occur continuously and are often limited by weather, length of pilot service, work shifts of flight test support personnel and "daylight hours". 19/ An analysis of spectrum resource availability at Edwards Air Force Base, for example, assumed a duration of only 8 hours per day. 20/ Based on these observations, it appears that the utilization of 2360 to 2395 MHz for AMT is unlikely to exceed 50% for a single day at any particular location. This

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17/ Boeing Comments at 9.

18/ AFTRCC Comments at 6-7.

19/ *Id.*

20/ "Effects of Diminishing Spectrum Resources on Aeronautical Telemetry," by Jim Rizzo and Greg Strombo, Edwards AFB, dated 25 October 2001. Available via the Internet at http://www.telemetryspectrum.org/itc2001proceedings/Rizzo.ppt. Last accessed June 11, 2008.

leaves a significant amount of time available for use of the spectrum by opportunistic MBANS devices. 21/

The implications of GEHC's research and analysis is clear: a large portion of the United States is currently unoccupied by AMT receive sites and otherwise available for MBANS operations in the 2360-2395 MHz band. In addition, where AMT receive sites exist and are operating in the band, such operations are generally not occurring continuously. These conditions make it possible for use of the band to be effectively shared on a secondary basis by opportunistic MBANS devices. Moreover, these findings do not even take into account other aspects and characteristics of AMT operations, more fully discussed below in Section VI, which make compatibility between AMT and MBANS operations even more likely.

Amateur and radio astronomy use of the 2360-2400 MHz band is also limited. Amateur operations are permitted on a primary basis in 2390-2400 MHz, but the Commission has stated that Amateur use of at least the 2390-2395 MHz portion "appears to be relatively light." 22/ Moreover, GEHC has uncovered no information that would suggest that the 2395-2400 MHz portion of the band is not also lightly used. Although a radio astronomy site operates at 2380 MHz in Arecibo, Puerto Rico, that is the only radio astronomy site at which the

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21/ In its comments, AFTRCC noted that "it is not the aircraft which is the potential interference victim here -- it is the parabolic dish antennas used to receive the telemetry radiated by the aircraft". AFTRCC Comments at 16. As such, the map of flight test footprints given by AFTRCC, *Id.*, Exhibit D, and the discussion of flight test footprints offered by Boeing, Boeing Comments at 7, are not relevant to an assessment of the likelihood of harmful interference to AMT operations from MBANS. Instead, such an analysis should be based on an examination of AMT receive sites.

22/ *See Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, Including Third Generation Wireless Systems*, ET Docket No. 00-258, 19 FCC Rcd 21350 (rel. Oct. 21, 2004), ¶ 47.

frequency is used. These facts provide further support for concluding that secondary and opportunistic MBANS use of the 2360-2400 MHz band is possible.

III. PROPOSED SECONDARY ALLOCATION FOR MBANS

The WCA states in its comments that it has no objection to the proposed MBANS allocation, provided that BSNs truly will be limited to secondary status. 23/ Although GEHC questions WCA's suggestion that the eventual MBANS rules state that MBANS operations are secondary to operations in all bands, 24/ any details regarding GEHC's proposed footnotes and Part 95 MBANS rules can be resolved in the rulemaking process. GEHC's request for secondary status reflects its ability to design a robust wireless link using time and frequency diversity to avoid interference from other, primary services or users. GEHC and any other medical device manufacturers seeking to develop equipment consistent with the MBANS rules would need to build a robust MBANS system in order to satisfy Federal Drug Administration ("FDA") requirements and to ensure customer acceptance. GEHC's request for an allocation of 40 MHz is based on the approach of time and frequency diversity where frequency agility can be used to find and use unused frequencies. Medical device manufacturers have every incentive to develop reliable products and GEHC would not be proposing secondary status for MBANS operations unless it was confident that MBANS devices could avoid interference from in-band and out-of-band primary sources.

In their comments, representatives of the amateur and aeronautical telemetry communities question the wisdom of a secondary allocation for a medical application. For example, in its comments AFTRCC discusses "the long and difficult history with the regulation

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23/ Comments of Wireless Communications Association International, Inc., ET Docket No. 08-59 (filed May 27, 2008) ("WCA Comments") at 1.

24/ *See* WCA Comments at 5.

of ‘secondary’ medical telemetry devices.” 25/ Some deeper examination of these concerns, which appear to reflect an outdated view of spectrum management, is warranted.

Wireless medical telemetry now has a thirty year history. At its inception, it operated either on a Part 90 licensed basis or on an unlicensed basis, primarily in unused TV channels. Due to the compelling benefits of wireless patient monitoring, the use of wireless medical telemetry grew steadily over the years, including application to higher-acuity patients. This trend of increasing adoption, which coincided with broad adoption of wireless technology throughout society in general, eventually outgrew the early, rather improvised regulatory regime that had been put in place to govern the operations, as well as the expertise of many medical device manufactures and users. A watershed event was the interference that occurred due to digital television testing in 1998 in Dallas Texas. Largely as a result of that incident, the Commission allocated licensed spectrum to the wireless medical telemetry service (“WMTS”) in 2000. Although the complete transition from legacy unlicensed and Part 90 regimes has been somewhat slow, by and large licensed WMTS has been a tremendous success. The trend towards continued adoption of WMTS in both 608-614 and 1400 MHz continues, and is a testament to the dedication of the Commission to allocate spectrum to accomplish important public interest objectives.

Since the establishment of WMTS, the Commission has established the Medical Implant Communications Service (“MICS”). The MICS rules allow low-power, short-range implanted medical devices to operate on a secondary basis to existing, sparsely distributed government users. MICS represents a clear precedent of low power wireless medical devices operating successfully on a secondary basis to incumbent, primary users. More recently, the Commission

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25/ AFTRCC Comments at 12.

has proposed the expansion of MICS to include additional spectrum and additional devices under the proposed MedRadio regime and, to its credit, has proactively inquired about the additional needs of emerging wireless medical devices – an inquiry which spawned GEHC's MBANS proposal.

Therefore, although wireless medical telemetry faced some challenges in its initial stages, device manufactures, users and regulatory bodies, including both the FCC and FDA, have since learned from these experiences. This insight was put to use successfully when WMTS and MICS were spawned, and further lessons learned from WMTS, MICS, U-NII, UPCS, and 3650-3700 MHz, as well as recent enabling technological advancements, are reflected in GEHC's current MBANS proposal. Given the tremendous progress that has been made, both in terms, of technology and on regulatory matters, and the significant amount of spectrum available, a secondary MBANS allocation in the 2360-2400 MHz band is wholly appropriate in this instance.

It should also be noted that the MBANS proposal differs significantly from the traditional, command and control approach to spectrum management reflected in the comments that question the wisdom of a secondary allocation proposal. MBANS devices would leverage high symbol rates to operate at low duty cycles, enabling Time Division Multiple Access ("TDMA"). In addition, with frequency agility and contention-based protocols, MBANS devices would be able to adapt to changing radio frequency environments to maintain the required quality of service. GEHC is very experienced in the development of reliable radio products, employing time, frequency and spatial diversity techniques to combat signal fading and interference. These techniques would be applied to MBANS, so that reliable products, which satisfy the requirements of health care users and the FDA, could be developed. Techniques used to ensure that MBANS devices do not experience harmful interference from primary users could, of course, be further specified in the eventual MBANS service rules, if necessary, in order to better ensure coexistence. Thus, in this case the admonition that medical devices not be allowed to operate on a secondary basis seems unnecessarily restrictive in view of prevailing interference mitigation techniques and standards and developments in the relevant technology.

In the unlikely event that an aircraft with active telemetry or a nearby Amateur radio transmits in close proximity to a MBANS device, the device's frequency agility and contention-based protocol (*e.g.* listen-before-talk) capabilities would enable it to halt its transmission on that frequency and utilize another frequency in the 2360 to 2400 MHz band. Given the AMT and other utilization characteristics presented above, GEHC believes that the proposed 40 MHz bandwidth affords a sufficient opportunity to find available bandwidth within the 2360 to 2400 MHz band and enable a robust MBANS solution.

The viability of a secondary MBANS allocation can also be assured through the use of interference mitigation techniques that have been successfully employed in the WMTS. For example, WMTS rules require the establishment of geographic exclusion zones for various sub bands to accommodate existing radio astronomy and government radar sites. They also incorporate the use of a frequency coordinator to maintain a database of users and locations. 26/ WMTS rules also prohibit use outside of the health care facilities. 27/ While GEHC initially proposed that MBANS device use not be restricted to health care facilities, the most important, safety critical and highest density uses of the devices would be in hospitals. In addition, the MBANS proposal includes limitation to use by health care providers or by prescription. As such, the concepts of geographic exclusion zones, registration databases and a frequency coordinator

26/ *See* 47 C.F.R. § 95.1111-1113.

27/ *See* 47 C.F.R. § 95.1107.

could certainly be applied, if necessary, to augment coexistence mechanisms GEHC has already proposed. It may also be possible for a MBANS coordination process to specify that specific portions of the 2360 to 2400 MHz band should be avoided if the potential user is proximate to a licensed aeronautical telemetry installation. This would address AFTRCC's concern of an "unknown and uncontrollable number of ubiquitous BSNs". 28/ These interference mitigation techniques and topics are all worthy of discussion and could be addressed efficiently in the NPRM.

IV. CHARACTERISTICS OF AERONAUTICAL FLIGHT TEST TELEMETRY THAT SUPPORT COEXISTENCE WITH MBANS

In its comments, Boeing explains how the amount of bandwidth required for AMT continues to increase significantly. 29/ This trend is, undoubtedly, the reason behind the recent allocation of 1374 MHz of additional spectrum above 4400 MHz for aeronautical flight test telemetry at WRC-07. 30/ This trend is also reflected by AFTRCC's comment of "wall-to-wall" concurrent operations. As AFTRCC stated:

> In a major area of the country, the Southwest, concurrent operations in the S-band are conducted "wall-to-wall" by the multiple ranges located in that area, i.e. Edwards Air Force Base, China Lake, Point Mugu, Vanderberg, Nellis Air Force Base, and Ft. Irwin, among others. 31/

28/ AFTRCC Comments at 23.

29/ Boeing Comments at 2.

30/ "World Radiocommunication Conference Provisional Final Acts" WRC-07 approved the allocation of 4400 – 4940 MHz, 5091 – 5150 MHz and 5925 – 6700 MHz for aeronautical mobile flight testing in ITU Region 2. Available via the Internet at http://www.telemetryspectrum.org/docs/Extract_Final_Acts_Prov.pdf. Last accessed June 11, 2008.

31/ AFTRCC Comments at 18-19.

It is worth noting however, that all of the test sites referenced by AFTRCC are government/military operations with well-defined perimeters and enforced boundaries. In fact, as AFTRCC has previously stated:

> For example, runways at Edwards AFB are 10 miles or more from the base perimeter. Even at Patuxent River Naval Air Station, the public is not allowed within 1 – 3 miles of the nearest runways. 32/

It should also be noted that government and commercial flight test activities likely yield a diverse set of applications with widely varying use of onboard data recording and telemetry. The size, weight and power available on the test platform, as well as the level of risk related to the tests being conducted, weigh heavily on the decision to use data recording versus telemetry. Although in its comments Boeing cites large numbers of monitored test points for 777 and 787 aircraft, it bears mentioning that, unlike missiles and small military fighter planes, which provide limited space for recording systems, large commercial jet liners afford significant power and space for onboard data recording. The disproportionate use of such onboard recording in lieu of telemetry will continue to expand, as noted by Charles Jones of Edwards Air Force Base:

> "Currently only about 1 percent of data being recorded is being telemetered. For a large scale test and training scenarios this is probably closer to 0.004 percent. Conservative projections suggest that by 2025, only about 0.07 percent will be telemetered for a single vehicle and about 0.00007 percent for a large scale test." 33/

By contrast, military flight test applications are reportedly more reliant than large commercial aircraft on telemetry. For example, Timothy Chalfont of Edwards Air Force Base has stated:

32/ Comments of Aerospace and Flight Test Radio Coordinating Council, ET Docket 00-258 (filed Dec. 1, 2003).

33/ "What if T&E Had Infinite Spectrum?" by Charles H Jones, Edwards Air Force Base. AIAA document 2005-7619. Presented at U.S. Air Force T&E Days, 6-8 December, 2005.

> "The demand for telemetry spectrum is a direct result of a revolution in weapon system technology and the streamlining of the weapon acquisition cycle." 34/

These comments and observations suggest that high-risk military flight tests are more dependent on telemetry than commercial flight tests. Because the military flight tests are generally conducted at designated test ranges that are located at some distance from populated areas, this factor should also be considered in arriving at a realistic assessment of the chances for coexistence between MBANS and AMT operations. Again, these issues can be more thoroughly explored in the NPRM and MBANS allocation proceeding.

V. AFTRCC'S LEARJET INTERFERENCE TESTS MISREPRESENT MBANS SIGNAL

AFTRCC's comments contain misleading statements based on flawed field tests performed by Learjet. In its comments, AFTRCC states:

> "The tests also showed interference at a distance of 3.2 miles from the tracking antenna even in the presence of ground clutter" 35/

However, according to exhibit G of AFTRCC's comments, the only portion of the test that also included a desired telemetry signal in order to allow actual assessment of interference effects was conducted with the interference source located at a fixed distance of only 0.7 miles from the receive site.

The Learjet tests themselves were flawed in several respects. First, they used interfering signals that were not representative of proposed MBANS devices. The test reportedly made

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34/ "Telemetry Spectrum Encroachment Taking Steps to Ensure the Future", by Timothy A. Chalfant, US Air Force Flight Test Center, Edwards AFB. Presented at SETE 2002 Conference, 28-30 October 2002, Sydney Australia. Available via the Internet at http://www.seecforum.unisa.edu.au/Sete2002/ProceedingsDocs/29P-Chalfant.pdf. Last accessed June 11, 2008.

35/ AFTRCC Comments at 21.

alternating use of two 1 mW (0 dBm) ERIP signals – one continuous wave (unmodulated) and a one frequency-modulated by a 1 kHz tone using 50 kHz deviation. Both of these signals had much higher power spectral density ("PSD") than the proposed MBANS rules would permit. GEHC proposed MBANS transmitters with maximum EIRP not exceeding the lesser of 1 mW or 10 log B dBm, where B is the 20 dB emission bandwidth in MHz. 36/ Therefore, Learjet should have used –10 dBm EIRP with its 50 kHz deviation, frequency modulated signal. Worse still, Learjet's use of a continuous wave signal in principle infinitely exceeded the proposed MBANS power spectral density limit!

Perhaps more importantly, the Learjet tests also failed to account for the low duty cycle and likely random frequency hopping of actual MBANS devices. GEHC has previously shared its estimated single MBANS device duty cycle of 1% to 5% and an aggregate duty cycle of < 25% for multiple MBANS devices on a single patient. 37/ In addition, the use in Learjet tests of an omnidirectional antenna mounted on the roof of a van created a much different radiation source than a small, printed antenna affixed to a human body. Random motion and changes in posture of a MBANS antenna mounted to a human body were also not included in the test.

The Learjet testing dealt only with the worst-case, where the MBANS transmitter is located outdoors and in the main beam of a large dish antenna. Such a testing approach is of limited use, considering the narrow beamwidth of the aeronautical telemetry receive antennas, the low likelihood of the worst-case scenario and the significant robustness of the AMT system to off-axis MBANS transmitters.

36/ *See* Ex Parte Comments of GE Healthcare, ET Docket No. 06-135 (filed Dec. 27, 2007).

37/ *Id.* Appendix C.

GEHC is also troubled by the measurements reported by Learjet. Appendix C compares the measurements reported by Learjet with theoretically expected measurements and shows that the measurements exceed the theoretically expected values by a substantial margin. Several possible explanations for this discrepancy exist. The test signal used could have actually had an EIRP higher than the 1mW intended or the actual signal being measured (and manifesting as interference to the actual airborne AMT signal) could have been a distinct and unrelated signal from an unknown radiator that was not part of the intended test. The nearly constant, received signal level of –67 dBm, given an increase in separation distance of 0.2 to 3.2 miles, would tend to support the latter explanation and, as discussed in the following section, there are numerous existing sources of emissions into the band. At any rate, the implausibility of the measurements reported certainly calls into question the overall validity of the Learjet test.

Finally, it should be noted that Learjet's test description appears to suggest that the cause of system failure was not interference overwhelming the desired AMT signal at the AMT receiver, but rather the antenna's automatic tracking mechanism locking onto the narrowband test signals and failing to track the desired airplane signal. It seems very likely that this failure would not have occurred if the test signal were properly representative of the proposed MBANS signal (*i.e.*, having wider bandwidth/lower PSD and being non-continuous/frequency-hopped.)

GEHC would welcome the opportunity to cooperate in future tests to ensure that representative MBANS test signals are used along with conditions representative of MBANS operation and with the goal of empirically characterizing acceptable MBANS operating parameters for various scenarios of interest (*e.g*. indoor vs. outdoor, various separation distances, etc).

VI. MITIGATION OF MBANS INTERFERENCE TO AERONAUTICAL TELEMETRY

In its comments, AFTRCC cites ITU recommendation ITU-R M.1459, which deals with protection of aeronautical mobile telemetry in both the 1.4 and 2.3 GHz bands, and, more particularly, protection from BSS satellites. This recommendation is at the crux of AFTRCC's arguments that proposed MBANS devices would cause harmful interference to aeronautical telemetry, so it bears careful examination. In its comments, AFTRCC states:

> "[GEHC] nonetheless argues that ITU-R Recommendation M.1459, which specifies protection standards for flight test telemetry, is 'overly conservative.' [GEHC] is in the medical telemetry business, and it is highly presumptuous to suggest that the protection standards for flight test telemetry are inappropriate". 38/

However, the recognition that the ITU-R Recommendation is overly conservative in many cases is not merely a presumption by GEHC but, rather, is acknowledged in several places in the recommendation itself, including:

> "The ITU Radiocommunication Assembly, considering . . .
>
> o) that <u>additional studies have been introduced in the ITU-R for determining the probability of interference to telemetry stations in the aeronautical mobile service which could lead to less stringent protection values, and that these studies are expected to continue</u>;
>
> p) that <u>telemetry stations in the aeronautical mobile service have a wide range of characteristics and some may have less stringent protection criteria values than those contained in the recommends</u>,
>
> 1.3 Modulation and bandwidth considerations
> pfds are currently specified in a 4 kHz bandwidth at these frequencies. <u>When the interfered-with signal is analogue or digital, limiting the interference levels in such a narrow bandwidth may lead to overly protective criteria.</u> The use of more appropriate averaging bandwidths for particular sharing situations can more accurately represent protection requirements.
>
> 1.8 General sharing assessment

38/ AFTRCC Comments at 20.

However, under favorable conditions, geometric conditions and where BSS (sound) satellite antenna discrimination to the telemetry receiving antennas in the order of 30 dB can be achieved, there is a reasonable expectation of successful sharing for low-power systems, i.e. in the order of –138 dB(W/(m^2*4 kHz)).

3 Practical measures to permit inter-service sharing

When interference calculations are being made, worst-case scenarios are likely to be used, which could tend to lead to the conclusion that co-frequency or co-channel sharing by different services cannot occur. 39/

More specifically, in the case of the S-band aeronautical telemetry operations at issue in this proceeding, simple consideration, as follows, shows that the recommended power flux density [PFD] limit of –180 dBW/square meter / 4 kHz for low elevation, terrestrial, interference sources is inappropriate. This limit erroneously assumes aeronautical telemetry links that are noise-limited, rather than interference-limited. 40/ While the noise-limited assumption is perhaps more valid for the 1.4 GHz band, a straightforward analysis of expected co-primary and out-of-band emissions ("OOBE") in 2360-2395 MHz shows that this assumption is simply not appropriate for that band.

The following observations are made assuming an exponential path loss exponent of n = 2.4 and the engineering calculations shown in the Appendix B:

- Fundamental emissions of a typical 10 Watt EIRP amateur radio transmission would interfere with aeronautical telemetry operations at a radius of 1,370 km line-of-sight, and the spurious OOBE of such operation, even assuming excellent 60 dB suppression, would interfere with AMT operations at a radius of 4.4 km.

39/ Recommendation ITU-R M.1459, *Protection Criteria for Telemetry Systems in the Aeronautical Mobile Service and Mitigation Techniques to Facilitate Sharing with Geostationary Broadcasting-Satellite and Mobile-Satellite Services in the Frequency Bands 1452-1525 MHz and 2310- 2360 MHz, 2000.*

40/ *See Ex Parte* Letter from William K. Keane, Counsel for Aerospace & Flight Test Radio Coordinating Council to Marlene S. Dortch, Secretary, FCC in ET Docket 06-135 (March 21, 2008).

- The allowable, spurious OOBE from a single, 2.4 GHz, Part 15 unlicensed, intentional radiator would interfere with aeronautical telemetry operations at a radius of 1.2 km. Moreover, due to the ubiquity of these devices, the aggregation effects of 2.4 GHz, Part 15 devices would greatly compound this effect.

- The allowable spurious OOBE from a single, 2.4 GHz, Part 18 ISM device (*e.g.* microwave oven, plasma discharge light, etc.) would interfere with aeronautical telemetry operations at a radius of 7.0 km.

- WCA comments in this proceeding predict "blanketing interference" in the proposed band due to OOBE from SDARS, MSS/ATC, WCS and BRS/EBS operations. 41/ For example, the allowable spurious OOBE from a single, WCS device would interfere with aeronautical telemetry operations at a radius of 17.8 km. These radio sources are or will soon become quite common, and would likely to be found within urban areas. If they affect aeronautical telemetry as suggested, then S-band aeronautical telemetry systems proximate to populated areas would be operating in an interference, rather than noise, limited manner.

AFTRCC and Boeing point out that aeronautical telemetry is sometimes a safety-of-life operation because it may be used to detect dangerous conditions so that flight tests may be aborted. However, since the calculations above demonstrate that interference exceeding the cited ITU-R M.1459 limit is already quite possible in 2360-2395 MHz due to several existing types of interference sources and since, even in the absence of interference, there is always a potential for failure of telemetry hardware onboard the aircraft or on the ground, flight testing presumably limits the absolute reliance on telemetry for safety and, for the most critical applications, likely includes provisions (*e.g.* diversity, extra link margin, etc.) that afford added link robustness. Moreover, additional risk mitigations are undoubtedly incorporated to help ensure continued safety in the event of telemetry outage, whatever the cause. Therefore, the potential consequence of interference is more one of lost economic productively than of impaired safety. The point here is only that the mere theoretical *possibility* of interference, however improbable, should not be used in

41/ *See* WCA Comment at 3.

conjunction with the safety-of-life argument to slam the door on a proposal to opportunistically share the band. The Commission's analysis should, of course, be based, instead, on the realistic *probability* of harmful interference, and not some theoretical possibility. 42/

The realistic probability of harmful interference occurrence is calculated to be 0.05% (i.e. 0.0005) using the approach in Appendix B. AFTRCC defined the worst-case situation for MBANS interference to an AMT receive site given an outdoor or indoor MBANS transmitter located in the mainlobe of the AMT receive antenna and separated by less than 62.1 km or 19.2 km, respectively. As shown in Appendix B, the mainlobe of the AMT receive antenna is directed at the MBANS transmitter for only 2.2% assuming uniform azimuth angle distribution about the AMT site.

The worst-case separation distances were calculated by AFTRCC using the power flux density limit of the ITU M.1459 recommendation. As discussed above and shown in the coexistence analysis of Appendix B, this pfd limit is overly conservative and corresponds to I/N = -29 dB (*i.e.*, the interference received from an MBANS device would be 29 dB *below* the thermal noise floor at the receiver). According to section 2.2.4 of ITU M.1459 recommendation Terrestrial sources are allowed –8.13 dB interference-to-noise (I/N) at the AMT receiver. 43/ An MBANS transmitter in the backlobe of an AMT receive antenna, experiences –8 dBi gain from the AMT antenna and requires only 218.2 meters separation to satisfy this I/N limit. As the

---

42/ *See, e.g., In re Revision of Part 15 of the Commission's Rules Regarding Ultra-wide Band Transmission Systems*, ET Docket No. 98-153, First Report and Order, 17 FCC Rcd 7435 (rel. Apr. 22, 2002), ¶ 152-171..

43/ See Recommendation ITU-R M.1459, *Protection Criteria for Telemetry Systems in the Aeronautical Mobile Service and Mitigation Techniques to Facilitate Sharing with Geostationary Broadcasting-Satellite and Mobile-Satellite Services in the Frequency Bands 1452-1525 MHz and 2310- 2360 MHz,* 2000, at Equation 1 and Figure 1.

AMT antenna mainlobe approaches the MBANS transmitter, 0 dBi gain requires a separation of 470 meters to satisfy the I/N limit of –8.13 dB. Given the information presented herein, such a small physical separation should be within existing area restrictions with respect to aeronautical telemetry facilities. For AMT receive sites, it is reasonable to assume that the owners and operators of such sites have the ability to control and restrict physical access to the facilities in order to prevent interference. 44/

VII. MITIGATION OF MBANS INTERFERENCE TO AMATEUR SERVICES

GEHC agrees with the honest and sensible assessment provided by the ARRL of the practical potential for interference to Amateur Radio caused by low power, contention-based MBANS devices. The ARRL comments that it "does not, frankly, expect a significant amount of harmful interference to Amateur operations at 2390 –2400 MHz from BSNs." 45/ The ARRL also suggests, however, that the band may be used for any Amateur signaling, even weak signal communications over very long propagation paths with very high transmitted signal levels and tall antennas located in residential areas. 46/ GEHC notes that, while theoretically possible, reception of such weak signal Amateur operations is already limited by the same Part 15, Part 18 and WCS OOBE issues outlined in the preceding section on aeronautical telemetry. In addition, such weak signal, long distance operations would typically utilize much narrower bandwidths, as

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44/ *See e.g., In The Matter of Amendment of Parts 2, and 15 of the Commission's Rules to Permit Use of Radio Frequencies Above 40 GHz for New Radio Applications,* ET Docket 94-124, Third Memorandum Opinion and Order, FCC 00-161, 15 FCC Rcd 10515 (rel. May 17, 2000) at ¶ 8 (assuming operator control over access to facilities at a distance of 1 km from telescopes at radio astronomy sites).

45/ Comments of ARRL, The National Association for Amateur Radio, ET Docket No. 08-59 (filed May 27, 2008) at 2.

46/ *Id.*

compared to the 1 MHz nominal MBANS bandwidths, which would tend to substantially mitigate any potential interference from MBANS.

VIII. AGGREGATION OF MBANS SIGNALS

GEHC's definition of MBANS is that of a single network per person with a gateway device coordinating transmission of sensors in a deterministic manner using time slots. These transmissions utilize data rates of 500 kbps to 1 Mbps to allow short burst messaging and to facilitate low power consumption from duty cycle < 25%. In other words, a MBANS network will radiate power in a 1 MHz channel less than 25% of the time. 47/

When multiple patients are collocated, such as in a hospital or other medical facility, the MBANS networks must share the time/frequency space by coordinating their transmissions in time and/or utilizing multiple frequencies. As a result, aggregated interference from a number of collocated MBANS networks scales according to N*Dc, where N is the number of MBANS networks (*i.e.* patients) and Dc is the duty cycle taken to be less than 25%. This factor is limited to N*Dc = 1 for proximate MBANS networks on a single, 1 MHz channel. As a result, the MBANS PFD levels present at the victim receiver will not increase with more than, typically, four MBANS networks, as these additional MBANS networks would occupy different, 1 MHz channels and not contribute to the PFD within the given channel.

CONCLUSION

The Commission's SPTFR on spectrum efficiency states:

> [M]ost "prime" spectrum has been assigned, and it is becoming increasingly difficult to find spectrum that can be made available either for new services or to expanding existing ones. To ensure that existing services can continue to grow and evolve to serve marketplace needs, and that new services have a chance to

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47/ *See* Ex *Parte* Comments of GE Healthcare, ET Docket No. 06-135 (Dec. 27, 2007).

> blossom and grow, it is important that the Commission continue to promote efficient access to and use of the radio spectrum. 48/

GEHC's proposal for the creation of the MBANS in the 2360 to 2400 MHz band is a concept that is well-aligned with the recommendations of efficient access to radio spectrum with respect to space and time contained in the SPTFR. MBANS devices present a very low likelihood of interference to primary users of the band, and GEHC is confident that, as a secondary user, it can avoid interference from primary users through the use of various contention-based protocols, diversity and frequency agility techniques. GEHC thus believes that proceeding to an NPRM is the appropriate next step for addressing technical details and engaging in collaborative discussions to resolve issues raised by other, interested parties.

GEHC appreciates the Commission's decision to seek comment on its MBANS proposal and urges the Commission to move expeditiously towards an NPRM, consistent with the record in this proceeding, that proposes the new spectrum allocation and rule changes necessary to make the next generation of wireless medical devices a reality.

Respectfully submitted,

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Counsel to GE HEALTHCARE

June 11, 2008

48/ Federal Communications Commission Spectrum Policy Task Force, *Report of the Spectrum Efficiency Working Group* (Nov. 15, 2002) at 4.

APPENDIX A

Map of US Hospitals and AFTRCC Reported Government and Civilian Test Flight Locations

Figure 1 contains a map of 6,853 hospitals located in the continental United States. Hospital zip codes were obtained from a commercial, Verispan database. Zip codes were translated into latitude and longitude coordinates using the US Census Bureau's ZIP code tabulation areas summary statistics (**http://www.census.gov/geo/ZCTA/zcta.html**). Using this approach, each dot in Figure 1 represents one or more hospitals within the same zip code.

Figure 2 shows the results of a search of the FCC Universal License System conducted on June 5, 2008. The search criteria included regular and active licenses assigned to the aeronautical and fixed radio service (AF), within the frequency range of 2360 to 2400 MHz. This search yielded only 16 licenses consisting of a total of 32 site locations.

Figure 3 provides a chart of the frequencies licensed for AF service use at these 32 licensed site locations. FCC license details show that each of these sites use only a small portion of the frequency band. The exception is Wichita where licenses held by Learjet and Boeing include 2360.5 through 2393.5 MHz.

Figure 4 contains a map of 157 flight test sites, both government and civilian, located within the continental United States. The flight test site listing including latitude and longitude information was provided to GE Healthcare by AFTRCC during January 2008. Of the 157 flight test sites, only 32 were found to hold active, regular licenses for the 2360 to 2400 MHz frequency range. These 32 sites from the FCC license details were mapped to test flight locations in the AFTRCC database and are indicated in Figure 4 as a dot surrounded by a circle.

The separation distance between each of the 6,853 hospitals and the 157 AMT sites was computed using the Haversine formula on a spherical earth of radius 6378.137 km. The minimum separation from each hospital to any of all of the AMT sites was stored. In addition, the minimum separation from each hospital to any of those 32 AMT sites holding an FCC license was stored. Figure 5 plots the cumulative distribution functions of the minimum hospital to AMT site separation considering all AMT (blue curve) or only FCC licensed AMT sites (red curve).

Table 1 lists the 165 flight test locations provided to GE Healthcare by AFTRCC via email on January 15, 2008.

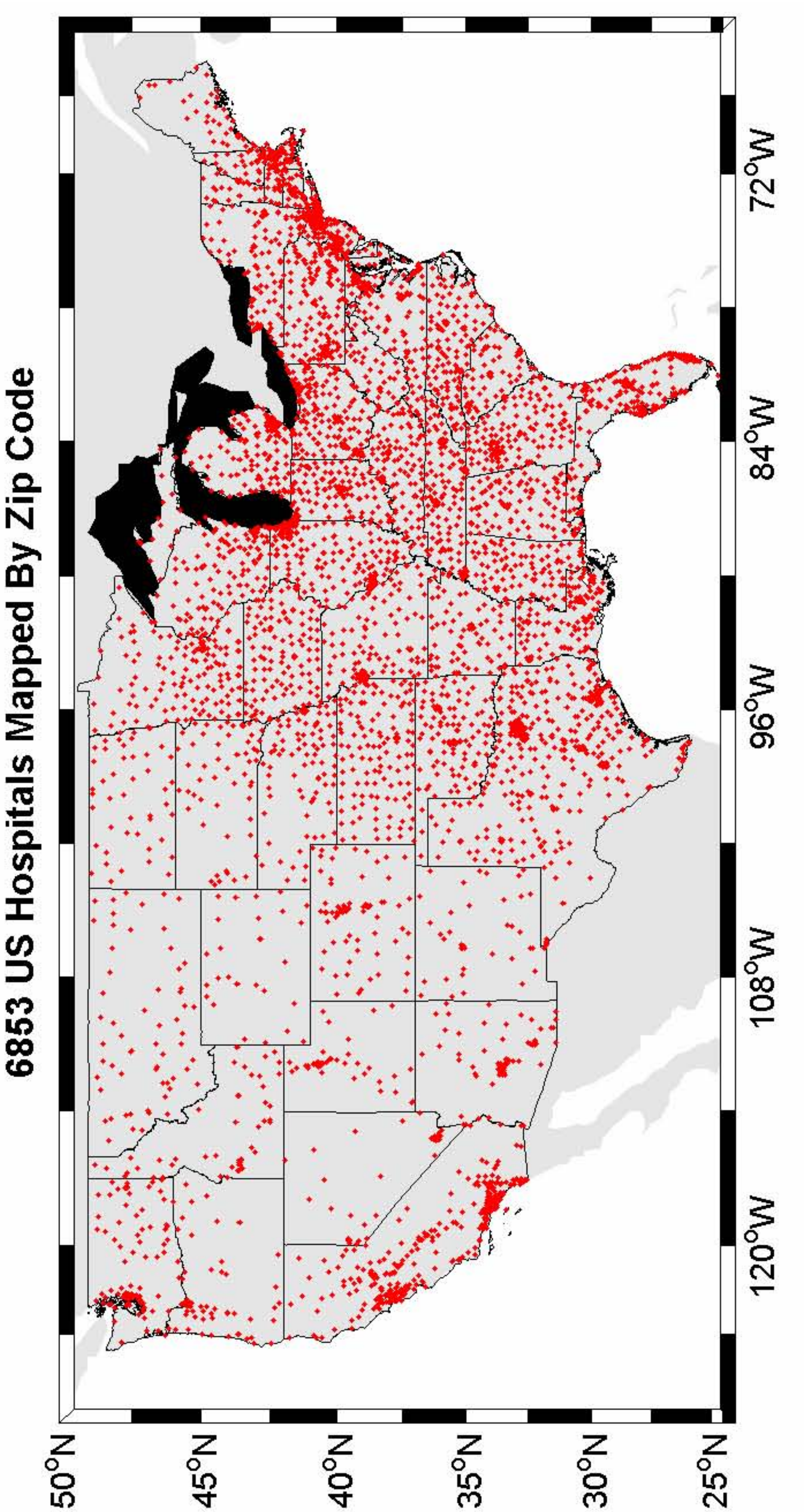

6853 US Hospitals Mapped By Zip Code
72°W
84°W
96°W
108°W
120°W
50°N
45°N
40°N
35°N
30°N
25°N

Figure 1

License Search

Search Results

Specified Search

Radio Service = **AF**
Authorization Type = **Regular**
Status = **Active**
Frequency Upper Band >= **2360**
Frequency Assigned <= **2400**

Matches **1- 16** (of **16**)

PA = Pending Application(s)
TP = Termination Pending
L = Lease

	Call Sign/Lease ID	Name	FRN	Radio Service	Status	Expiration Date
1 PA	KA97185	BELL HELICOPTER TEXTRON INC	0003596020	AF	Active	08/03/2009
2	KA97270	THE BOEING COMPANY	0001583483	AF	Active	12/14/2009
3	KA98066	THE BOEING COMPANY	0001583483	AF	Active	03/16/2009
4	KA98076	SIKORSKY AIRCRAFT CORPORATION	0003573821	AF	Active	08/08/2012
5	KA98091	Learjet Inc.	0003467586	AF	Active	04/10/2011
6	KA98095	Learjet Inc.	0003467586	AF	Active	04/01/2011
7	KA98112	ORBITAL SCIENCE CORP	0014578496	AF	Active	05/01/2011
8	KA98127	THE BOEING COMPANY	0001583483	AF	Active	01/01/2012
9	KA98136	Learjet Inc.	0003467586	AF	Active	08/21/2008
10	KA98140	Learjet Inc.	0003467586	AF	Active	08/21/2008
11	KA98142	THE BOEING COMPANY	0001583483	AF	Active	07/07/2009
12	WQBU279	Learjet Inc.	0003467586	AF	Active	12/14/2009
13	WQFL443	Learjet Inc.	0003467586	AF	Active	04/01/2011
14	WQFZ869	THE BOEING COMPANY	0001583483	AF	Active	11/21/2011
15	WQHC922	Aviation Technology Group, INC.	0014363139	AF	Active	01/09/2012
16	WQHV942	Cirrus Design Corporation	0016855041	AF	Active	08/20/2012
	Call Sign/Lease ID	Name	FRN	Radio Service	Status	Expiration Date

Figure 2

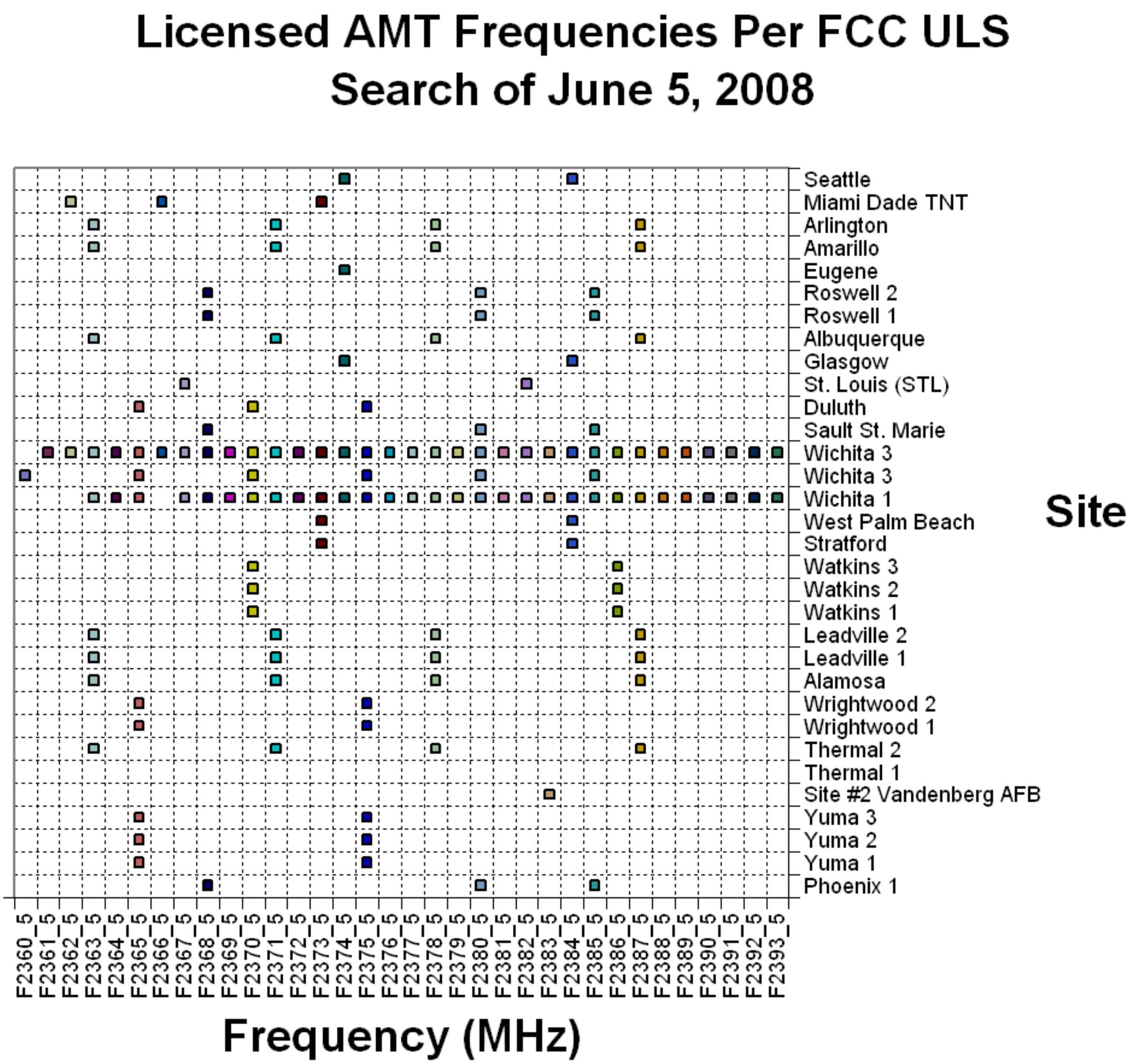

Licensed AMT Frequencies Per FCC ULS
Search of June 5, 2008
Seattle
Miami Dade TNT
Arlington
Amarillo
Eugene
Roswell 2
Roswell 1
Albuquerque
Glasgow
St. Louis (STL)
Duluth
Sault St. Marie
Wichita 3
Wichita 3
Wichita 1
West Palm Beach
Stratford
Watkins 3
Watkins 2
Watkins 1
Leadville 2
Leadville 1
Alamosa
Wrightwood 2
Wrightwood 1
Thermal 2
Thermal 1
Site #2 Vandenberg AFB
Yuma 3
Yuma 2
Yuma 1
Phoenix 1
Site
F2360_5
F2361_5
F2362_5
F2363_5
F2364_5
F2365_5
F2366_5
F2367_5
F2368_5
F2369_5
F2370_5
F2371_5
F2372_5
F2373_5
F2374_5
F2375_5
F2376_5
F2377_5
F2378_5
F2379_5
F2380_5
F2381_5
F2382_5
F2383_5
F2384_5
F2385_5
F2386_5
F2387_5
F2388_5
F2389_5
F2390_5
F2391_5
F2392_5
F2393_5
Frequency (MHz)

Figure 3

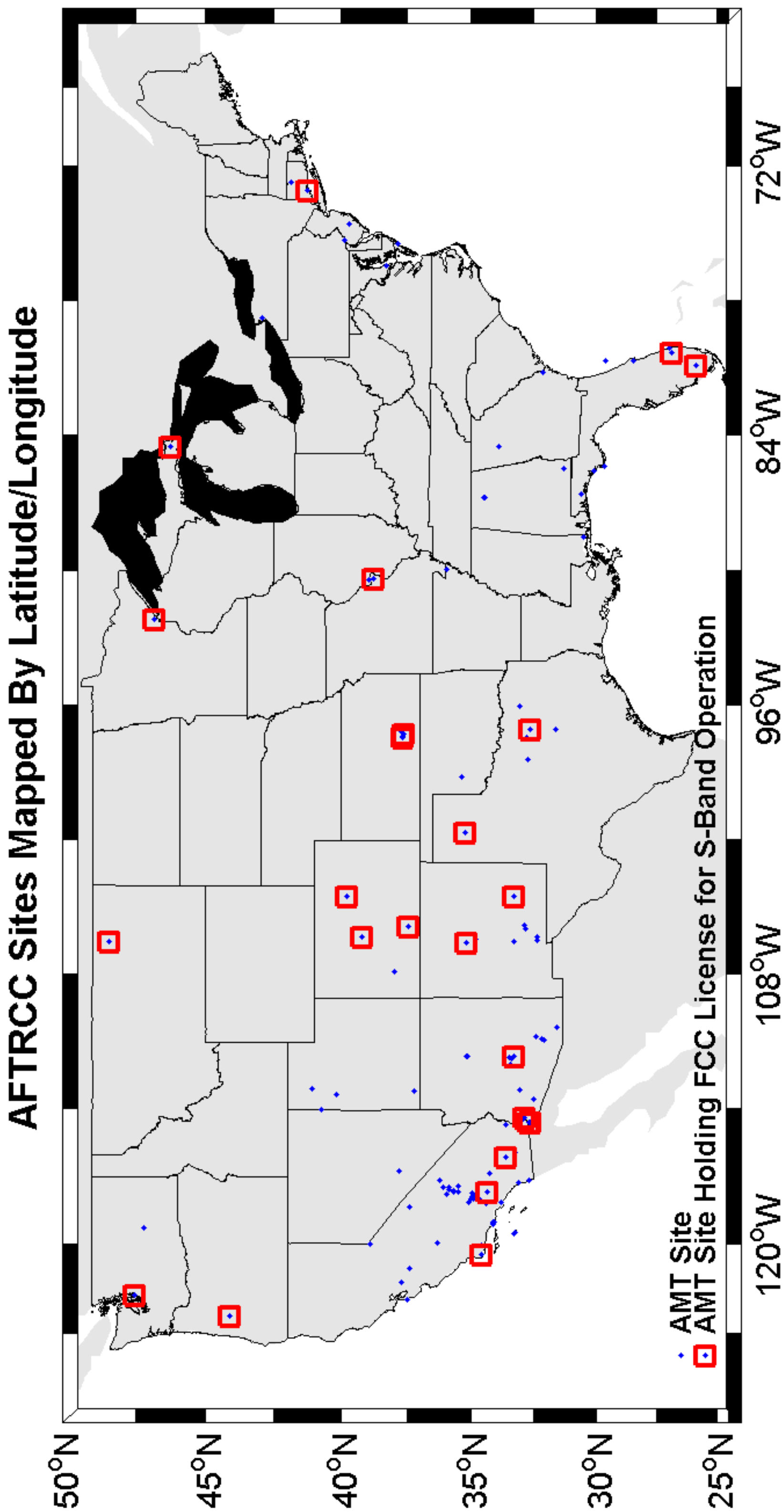
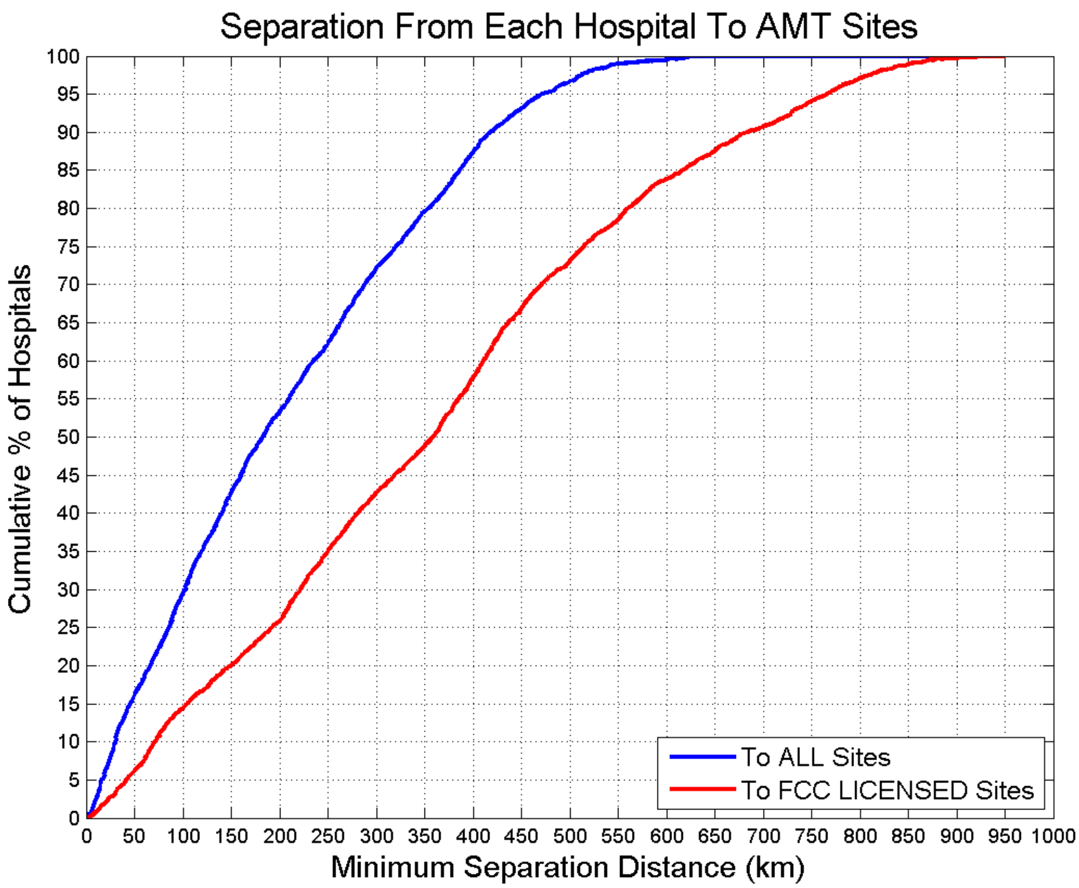

AFTRCC Sites Mapped By Latitude/Longitude
AMT Site
AMT Site Holding FCC License for S-Band Operation
50°N
45°N
40°N
35°N
30°N
25°N
120°W
108°W
96°W
84°W
72°W

Figure 4



Separation From Each Hospital To AMT Sites
Cumulative % of Hospitals
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
Minimum Separation Distance (km)
To ALL Sites
To FCC LICENSED Sites

Figure 5

Table 1

Antenna ID	STATE	LATITUDE dd-mm-ss.s N	LONGITUDE ddd-mm-ss.s W	ANT ELEV AGL (Ft)
Dothan	AL	31-19-00	085-27-00	16.0
Telemetry Station 4	AL	34-26-40	86-45-32	50*
Telemetry Station @ 7855	AL	34-30-28	86-45-34	50*
Blytheville	AR	35-58-00.0	89-57-00.0	15.0
Contravies J	AZ	32-30-36	113-33-36	50*
Flagstaff 1	AZ	35-08-18	111-40-16	16.0
Flagstaff 2	AZ	35-12-00	111-38-00	16.0
Huachuca	AZ	31-35-47	110-21-49	50*
Mesa 1	AZ	33-24-00	111-46-00	16.0
Mesa 2	AZ	33-27-39	111-43-42	16.0
Mesa 3	AZ	33-28-12	111-43-17	16.0
Mt. Lemmon	AZ	32-25-31	110-47-22	50*
Oatman Mountain	AZ	33-03-33	113-08-41	50*
Phoenix 1	AZ	33-18-28	111-39-19	50*
Phoenix 2	AZ	33-26-34	112-00-23	50*
Sierra Vista	AZ	31-35-18	110-20-39	16.0
Site 4	AZ	32-53-59	114-22-45	50*
Site 2	AZ	32-56-23	114-25-09	50*
Site 18	AZ	33-11-23	114-21-33	50*
Tucson 1	AZ	32-06-58	110-56-28	16.0
Tucson 2	AZ	32-10-00	110-53-00	16.0
Yuma 1	AZ	32-39-12	114-37-09	16.0
Yuma 2	AZ	32-43-00	114-37-00	16.0
Yuma 3	AZ	32-51-36	114-23-48	16.0
Big Bear	CA	34-16-00	116-51-00	50*
Bishop	CA	37-22-24	118-21-54	16.0
Bldg 151	CA	34-54-06.7	117-52-29.0	50*
Bldg 145	CA	34-54-05.5	117-52-40.3	50*
Bldg 1220	CA	34-55-01.5	117-53-58.3	50*
Bldg 1635	CA	34-55-45.8	117-53-18.5	50*
Bldg 1630	CA	34-55-43.1	117-53-11.9	50*
Bldg 4795	CA	34-58-13.7	117-55-54.7	50*
Bldg 5790	CA	34-58-36.0	118-00-40.0	50*
Bldg 8022	CA	34-55-57.1	117-45-45.4	50*
Blythe	CA	33-37-09	114-43-00	16.0
Carlsbad	CA	33-08-00	117-17-00	16.0
Cinder	CA	35-55-41	117-47-34	50*
Crows Landing	CA	37-24-00	121-06-00	16.0
Echo Main	CA	35-51-48	117-29-42	50*
G-100	CA	35-31-06	116-85-18	50*
J-62	CA	35-51-14	117-35-56	50*
Kim Site	CA	35-72-48	117-11-00	50*
Laguna Peak 1	CA	34-06-30	119-03-50	50*
Laguna Peak 2	CA	34-06-14	119-03-44	50*
Laurel	CA	35-28-46	117-40-59	50*
LeMoore NAS	CA	36-20-00	119-57-00	16.0
Long Beach	CA	33-49-09	118-08-23	16.0
Los Angeles	CA	34-22-51	118-11-50	50*
MFTS	CA	34-57-29	117-54-43	50*
Mojave	CA	35-04-00	118-09-00	16.0
Mugu 2	CA	34-07-12	119-07-24	32.82
Mugu 3	CA	34-07-01	119-06-59	32.79
Mugu 4	CA	34-07-57	119-07-11	32.49
National Lab	CA	37-41-19	121-42-29	50*
Pad 22	CA	34-55-11.6	117-52-16.7	50*
Palmdale 1	CA	34-36-36	118-04-26	16.0
Palmdale 2	CA	34-38-00	118-05-00	16.0
Parrot	CA	36-04-59	117-28-54	50*
Pillar Point	CA	37-29-57	122-29-57	50*
Rooftop	CA	34-56-59	117-53-15	50*
Salton Sea	CA	33-14-00	115-57-00	16.0
San Diego	CA	32-42-53	117-09-21	50*
San Nicholas Island B1	CA	33-15-00	119-29-24	50*
San Nicholas Island B2	CA	33-15-41	119-29-39	50*
San Nicholas Island B3	CA	33-15-33	119-29-05	50*
San Nicholas Island C1	CA	33-15-15	119-29-22	50*
San Nicholas Island C2	CA	33-15-12	119-29-28	50*
San Nicholas Island GF1	CA	33-16-40	119-32-07	50*
San Nicholas Island GF2	CA	33-16-58	119-32-58	50*
San Nicholas Island E1	CA	33-16-46	119-32-55	50*
Santa Ynez	CA	34-36-27	120-04-28	16.0
Shrike	CA	35-41-23	117-40-56	50*
Site #1	CA	34-33-56	120-30-04	50*
Site #2	CA	34-33-58	120-30-02	50*
Site #3	CA	34-33-56	120-30-05	50*
Site Pad	CA	34-53-32.2	118-00-32.0	50*
South Lake Tahoe	CA	38-54-00	120-00-00	16.0
T-Pad	CA	35-41-37	117-37-38	50*
Thermal 1	CA	33-37-36	116-09-39	16.0
Thermal 2	CA	33-37-35	116-09-36	30.0
Triplex	CA	34-57-37	117-54-42	50*
Wrightwood 1	CA	34-21-08	117-40-30	16.0
Wrightwood 2	CA	34-21-07	117-40-29	16.0
Alamosa	CO	37-26-04	105-52-03	30.0
Leadville 1	CO	39-13-13	106-19-03	30.0
Leadville 2	CO	39-13-13	106-19-00	16.0
Telluride	CO	37-57-13	107-54-30	16.0
Watkins 1	CO	39-47-26.2	104-32-53.6	40.0
Watkins 2	CO	39-47-26.4	104-32-53.6	40.0
Watkins 3	CO	39-47-27.2	104-32-53.6	40.0
Bloomfield	CT	41-51-42	72-42-12	50*
Stratford	CT	41-15-03	073-06-01	75.0
New Castle	DE	39-40-54.5	74-35-52.6	50.0
Eglin	FL	30-29-00	088-32-00	16.0
JDMTA (TAA-50/1)	FL	26-59-01	80-06-31	57.27
JDMTA (TAA-50/2)	FL	26-59-01	80-06-30	60.98
JDMTA (TAA-50/3)	FL	26-58-57	80-06-28	85.54
JDMTA (TAA-50/5)	FL	26-58-55	80-06-26	61.5
Kennedy	FL	29-36-00	080-40-00	16.0
Tel-4 (TAA-24A)	FL	28-27-46	80-39-10	57.7
Tel-4 (TAA-3C)	FL	28-27-49	80-39-11	59.56
Test Site B-4A (#1)	FL	30-35-20	086-37-31	50*
Test Site B-4A (#2)	FL	30-35-18	086-37-31	50*
Test Site B-4A (#3)	FL	30-35-19	086-37-33	50*
Test Site B-4B (#1)	FL	30-35-16	086-37-00	50*
Test Site B-4B (#2)	FL	30-35-17	086-37-58	50*
Test Site B-4B (#3)	FL	30-35-15	086-36-59	50*
Test Site D-3 (#1)	FL	29-40-39	085-20-58	54.8
Test Site D-3 (#2)	FL	29-40-40	085-20-57	62.61
Test Site D-3 (#3)	FL	29-40-40	085-20-56	69.22
Tyndall #1	FL	30-03-32.52	85-34-36.46	120
Tyndall #2	FL	30-03-30.03	85-34-39.35	105
Tyndall #3	FL	30-03-32.54	85-34-39.40	130
Tyndall #4	FL	30-03-51.00	85-34-41.62	35
West Palm Beach	FL	26-54-24.3	80-19-14.4	75.0
Marietta	GA	33-54-24	84-31-09	50*
Savannah	GA	32-08-09	81-11-38	50*
GRK-8A#1a	HI	22-07-46	159-43-26	50*
GRK-8A#2	HI	22-07-48	159-43-25	50*
GRK-8A#1b	HI	22-07-50	159-43-25	50*
MR-150-14#1a	HI	22-07-49	159-43-27	50*
MR-150-14#2a	HI	22-07-49	159-43-27	50*
MR-150-14#1b	HI	22-07-24	159-39-56	50*
MR-150-14#2b	HI	22-07-25	159-39-55	50*
Test Facility	HI	22-03-00	1159-47-00	21.0
Wichita 1	KS	37-37-38.6	97-16-40.15	65.2
Wichita 2	KS	37-38-34.1	97-25-01.2	93.0
Wichita 3	KS	37-39-59	97-26-25	65.0
Wichita 4	KS	37-41-38.0	97-13-12.0	50.0
Hangar 101	MD	38-17-22	076-25-24	45.0
Sault St. Marie	MI	46-14-52	84-28-15	50*
Duluth	MN	46-50-20.2	92-12-10.2	25.0
St. Charles	MO	38-55-35	90-25-23	50*
St. Louis	MO	38-45 04.0	90-21-24.5	50.0
Glasgow	MT	48-25-21	106-32-10	16.0
Alamagordo	NM	32-50-24	105-59-26	16.0
Albuquerque	NM	35-11-39	106-34-30	30.0
JIG-13 Building 335	NM	32-22-50	106-28-31	50*
JIG-10 Salinas Peak	NM	33-17-55	106-31-56	50*
JIG-56 Dry Site	NM	32-23-14	106-19-42	50*
JIG-67 Alamo Lookout	NM	32-52-21	105-48-43	50*
Roswell 1	NM	33-18-00	104-32-00	16.0
Roswell 2	NM	33-17-59	104-31-20.6	15.0
Sandia Labs	NM	34-49-20	106-26-30	50*
Test Range	NV	37-48-00	116-45-00	50*
Buffalo	NY	42-56-54	078-44-15	16.0
Burns Flat	OK	35-20-37.2	99-12-12.0	15.0
Eugene	OR	44-07-39	123-13-12	16.0
Philadelphia	PA	39-51-38	75-19-11	42.7
Puerca Point TM Site	PR	18-13-53	65-35-42	70.0
Pico Del Este Site	PR	18-16-04	65-45-29	50*
Amarillo	TX	35-12-49	101-42-31	30.0
Arlington	TX	32-40-0.0	97-05-53	50.0
Fort Worth 1	TX	32-46-50.7	97-26-54.4	135.0
Fort Worth 2	TX	32-46-46.4	97-26-51.7	135.0
Greenville	TX	33-03-47.1	96-04-10.7	65.0
Palo Pinto	TX	32-43-36.8	98-25-57.4	8.0
Waco	TX	31-38-21.6	97-04-08.6	20.0
Granite Peak	UT	40-09-29	113-21-01	50*
Grassy Mountain West	UT	40-65-40	113-05-12	50*
Hurricane	UT	37-13-40	113-13-05	50*
Wendover Peak	UT	40-45-11	114-01-11	50*
WFF	VA	37-51-03	075-28-14	35.0
Moses Lake	WA	47-12-46	119-19-21	16.0
Seattle	WA	47-32-11	122-18-51	115.0

APPENDIX B

Engineering Analysis

OUT OF BAND EMISSIONS FROM OTHER WIRELESS SERVICES

The following table shows GE Healthcare's calculations to assess the physical separation from an aeronautical telemetry receiver required for various types of existing interference sources to satisfy the ITU-R M.1459 power flux density limit cited by AFTRCC.

	Amateur TV Fundamental	Amateur Spurious OOBE	Part 15 Spurious OOBE	Part 18 Spurious OOBE	WCS Spurious OOBE
Interference EIRP [W]	10.00	1.00E-05	7.50E-08	5.20E-06	5.00E-05
Distance [km]	**1370.00**	**4.40**	**1.20**	**7.00**	**17.80**
Path Loss Exponent	2.40	2.40	2.40	2.40	2.40
Power Flux Density [W/m^2]	1.49E-15	1.43E-15	2.43E-16	2.45E-16	2.50E-16
Power Flux Density [dBW/m^2]	-148.27	-148.43	-156.14	-156.11	-156.01
Power Flux Density [dBW/m^2/4kHz]	**-180.03**	**-180.20**	**-180.12**	**-180.09**	**-179.99**
Interference Field Strength at Receiver [uV/m]	0.749	0.735	0.303	0.304	0.307
Interference Field Strength at Receiver [dBuV/m]	-2.51	-2.67	-10.38	-10.35	-10.25
RX Antenna Gain [dBi]	30.00	30.00	30.00	30.00	30.00
Frequency [MHz]	2370.00	2370.00	2370.00	2370.00	2370.00
Received Interference Power [W]	1.90E-15	1.83E-15	3.10E-16	3.12E-16	3.19E-16
Received Interference Power [dBm]	-117.22	-117.38	-125.09	-125.06	-124.96
Interference Bandwidth [Hz]	6000000	6000000	1000000	1000000	1000000
Received Interference Power Spectral Density [dBm/Hz]	-185.00	-185.16	-185.09	-185.06	-184.96
Receiver Noise Figure [dB]	4.40	4.40	4.40	4.40	4.40
Ratio of Received Interference to Receiver's Intrinsic Noise [dB]	-16.40	-16.56	-16.49	-16.46	-16.36
Comments	Typical 10W Amateur TV	10 W Amateur TV with excellent 60 dB OOBE suppression	500uV/m / 1MHz @ 3m per 47 CFR 15.209	25uV/m/MHz @ 300m limit converted according to FCC MP-5 to 4167uV/m/MHz measured at 3m.	-43 dBW / 1MHz per 47 CFR 27.53(a)

AMT RECEIVE ANTENNA MAINLOBE PROBABILITY

The ITU-R M.1459 recommended power flux density limit of -180 dBW/m^2 over a 4 kHz bandwidth assumes the interference source resides in the mainlobe of the AMT receive antenna. This assumption underlies the AFTRCC's engineering analysis. 49/ However, given the highly directional antennas used for AMT receive operations, this mainlobe assumption holds for only a small percentage of situations.

49/ Aerospace and Flight Test Radio Coordinating Council, Comments of May 27, 2008 at Exhibit C.

The ITU M.1459 recommendation defines a composite antenna pattern based on measurements of L-band antennas of diameter 2.44 meters. 50/ For this discussion we conservatively neglect any increase in dish antenna directivity due to increasing the frequency of operation from L-band to S-band or to the use of larger diameter dish antennas, and consider the composite antenna pattern given by equation 1 and figure 1 of the recommendation.

The composite antenna pattern characteristic describes half of the azimuth pattern and exhibits gain in excess of 0 dBi from 0 to 23 degrees. To account for the dish antenna's pattern nulls, we subtract 3 degrees from this value to yield 20 degrees. Assuming uniform azimuth angle distribution and mapping this 20 degree half beamwidth to the 360 degree azimuth range yields (20/180) = 0.11. This value of 11% represents the probability of an AMT receive antenna having gain exceeding 0dBi MBANS transmitter.

GE Healthcare's assumption of 0 dBi represents an attempt to balance this probability of mainlobe occupancy with the ITU M.1459 composite antenna pattern that specifies –8 dBi gain over an angular range of 48 to 180 degrees. Further review of the ITU M.1459 recommendation and Viasat antenna datasheets 51/ permits defining the following probabilities of AMT receive antenna gain in the direction of the MBANS transmitter:

$G_{\text{AMT receive}} > 0$ dBi	20 deg half beamwidth	11.1% azimuth probability
$G_{\text{AMT receive}} > 10$ dBi	6.6 deg half beamwidth	3.7% azimuth probability
$G_{\text{AMT receive}} > 30$ dBi	4 deg half beamwidth	2.2% azimuth probability

50/ See Recommendation ITU-R M.1459, *Protection Criteria for Telemetry Systems in the Aeronautical Mobile Service and Mitigation Techniques to Facilitate Sharing with Geostationary Broadcasting-Satellite and Mobile-Satellite Services in the Frequency Bands 1452-1525 MHz and 2310- 2360 MHz*, 2000, at Equation 1 and Figure 1.

51/ Aerospace and Flight Test Radio Coordinating Council, Comments of May 27, 2008 at Exhibit B.

PROBABILITY OF WORST-CASE AMT INTERFERENCE SCENARIO

The worst-case interference to AMT from MBANS will occur when the MBANS transmitter is located in the mainbeam of the AMT receive antenna. The probability of this unlikely event occurring can be estimated as:

$$P_{\text{AMT worst case}} = P_{\text{Space}} * P_{\text{Azimuth}} * P_{\text{Frequency}} * P_{\text{Time}}$$

Where the factors are taken as:

P_{Space} = Probability of an outdoor MBANS transmitter being located within 20 km of any AMT site. As shown in Appendix A, only 6.1% of hospitals are located < 20 km from any AMT site. Furthermore, 20 km is consistent with the distance calculated by AFTRCC to achieve the ITU M.1459 pfd limit given an indoor MBANS transmitter..

P_{Azimuth} = Mainlobe with 30 dBi antenna gain occurs for only 2.2% of antenna azimuth pattern.

$P_{\text{Frequency}}$ = Assume that 30 MHz out of 40 MHz within the 2360 to 2400 MHz band is being used for AMT activities. Given the information in Appendix A, this 75% factor is conservative for commercial sites.

P_{Time} = 50% reflecting the “daylight” operation of AMT activities.

Using these values the probability of worst-case AMT interference from MBANS occurrence is calculated to be only 0.1%

$P_{\text{AMT worst case}}$ = 0.061 * 0.022 * 0.75 * 0.50 = 0.0005 = .05%

MBANS COEXISTENCE ANALYSIS

GE Healthcare's previous coexistence analysis 52/ estimated power level and interference-to-noise ratio at incumbent receivers by applying a simplified, propagation model that computed path loss as $10*n*\log_{10}(4*pi*d*f/c)$. In this expression, n is the path loss exponent taken as 2.4 while d is the distance in meters, f is frequency and c is $3x10^8$ meters/second. The coexistence analysis of this appendix follows the same methodology but includes a revised propagation model to be consistent with that used by AFTRCC in its comments. 53/ In the table below, path loss is computed as $20*\log_{10}(4*pi*f/c) + 10*n*\log_{10}(d)$.

According to section 2.2.4 of the ITU M.1459 recommendation, terrestrial sources are allowed –8.13 dB interference-to-noise (I/N) at the AMT receiver. 54/ An MBANS transmitter in the backlobe of an AMT receive antenna, experiences –8 dBi gain from the AMT antenna and requires only 218.2 meters separation to satisfy this I/N limit. As the AMT antenna mainlobe approaches the MBANS transmitter, 0 dBi gain requires a separation of 470 meters to satisfy the I/N limit of –8.13 dB. If an MBANS transmitter occupied the 30 dBi mainlobe peak of an AMT receive antenna then 8,350 meter separation would be required to satisfy the I/N limit. By contrast, the last row in the table reflects the 62.1 km separation suggested by AFTRCC's worst-case analysis. Notably, such extreme separation would result in received MBANS power 29 dB below the intrinsic AMT receiver noise floor – even for the most sensitive AMT receivers suggested by ITU M.1459 (i.e. 2 dB noise figure).

52/ *See* GE Healthcare *Ex Parte* Comments, Appendix C, ET Docket No. 06-135 (Dec. 27, 2007).

53/ Aerospace and Flight Test Radio Coordinating Council, Comments of May 27, 2008 at Exhibit C.

54/ See Recommendation ITU-R M.1459, *Protection Criteria for Telemetry Systems in the Aeronautical Mobile Service and Mitigation Techniques to Facilitate Sharing with Geostationary Broadcasting-Satellite and Mobile-Satellite Services in the Frequency Bands 1452-1525 MHz and 2310- 2360 MHz,* 2000.

Coexistence Analysis for MBANS with Aeronautical and Amateur Receiver Categories, (Path Loss n=2.4)

[A] VICTIM RCVR CATEGORY	[B] FREQ. (MHz)	[C] MBANS EIRP (dBm)	[D] MBANS AND VICTIM DISTANCE (meters)	[E] PATH LOSS, n=2.4 (dB)	[F] RECEIVE ANTENNA GAIN (dBi)	[G] MBANS INTERFERENCE AT VICTIM (dBm)	[H] VICTIM RECEIVER BANDWIDTH (MHz)	[I] MBANS INTERFERENCE IN VICTIM FRONT END RF CHANNEL (dBm)	[J] NET INTERFERENCE TO VICTIM RECEIVER (dBm)	[K] VICTIM RECEIVER NOISE FIGURE (dB)	[L] VICTIM RECEIVER NOISE FLOOR (dBm)	[M] MBANS I/N RATIO (dB)
1	2393.0	0	10	64.02	-6.0	-70.02	6.0	-70.02	-76.04	7.0	-99.19	23.15
1	2393.0	0	42.8	79.17	-6.0	-85.17	6.0	-85.17	-91.19	7.0	-99.19	8.01
1	2393.0	0	100	88.02	-6.0	-94.02	6.0	-94.02	-100.04	7.0	-99.19	-0.85
1	2393.0	0	1,000	112.02	-6.0	-118.02	6.0	-118.02	-124.04	7.0	-99.19	-24.85
2	2399.5	0	10	64.04	-3.0	-67.04	0.005	-90.05	-96.08	15.0	-121.99	25.91
2	2399.5	0	55.7	81.94	-3.0	-84.94	0.005	-107.96	-113.98	15.0	-121.99	8.01
2	2399.5	0	100	88.04	-3.0	-91.04	0.005	-114.05	-120.08	15.0	-121.99	1.91
2	2399.5	0	125	90.37	-3.0	-93.37	0.005	-116.38	-122.40	15.0	-121.99	-0.41
2	2399.5	0	1,000	112.04	-3.0	-115.04	0.005	-138.05	-144.08	15.0	-121.99	-22.09
3	2377.5	0	10	63.96	0.0	-63.96	10.0	-63.96	-69.98	2.0	-101.98	31.99
3	2377.5	0	100	87.96	0.0	-87.96	10.0	-87.96	-93.98	2.0	-101.98	7.99
3	2377.5	0	129.3	90.64	0.0	-90.64	10.0	-90.64	-96.66	2.0	-101.98	5.32
3	2377.5	0	218.2	96.10	0.0	-96.10	10.0	-96.10	-102.12	2.0	-101.98	-0.14
3	2377.5	0	218.2	96.10	-8.0	-104.10	10.0	-104.10	-110.12	2.0	-101.98	-8.14
3	2377.5	0	470	104.09	0.0	-104.09	10.0	-104.09	-110.12	2.0	-101.98	-8.14
3	2377.5	0	8,350	134.08	30.0	-104.08	10.0	-104.08	-110.11	2.0	-101.98	-8.13
3	2377.5	0	62,100	155.00	30.0	-125.00	10.0	-125.00	-131.02	2.0	-101.98	-29.04

APPENDIX C

Examination of Learjet Field Test Measurements

The following figure compares the measurements reported by Learjet in Exhibit G of AFTRCC's comments with theoretically expected measurements for free-space propagation and also for propagation with path loss exponent of n=2.4. The comparison is striking as the measurements reported by Learjet exceed the expected n=2.4 path loss, which was expected due to non-line-of-sight conditions with ground clutter described in the test report, by an average of 19.2 dB! Moreover, four of the five reported measurements also exceed the theoretical *free space* loss by an average of 6.4 dB with a range of 3-16 dB!